LOWER CRETACEOUS CHIMAEROIDS (CHONDRICHTHYES: HOLOCEPHALI) FROM THE GREAT ARTESIAN BASIN, AUSTRALIA

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Recently collected chimaeroid specimens from Lower Cretaceous (Albian) marine sediments of the Great Artesian Basin in Queensland, Australia, have enabled the taxonomy of these relatively rare fishes in these deposits to be clarified. Two Lower Cretaceous taxa were described from Australia in recent times, viz. *Edaphodon eyrensis* Long, 1985, and *Ptyktoptychion tayyo* Lees, 1986. A new species, *P. wadeae*, is here described from palatine, vomerine and mandibular tooth plates and is shown to differ significantly from the existing taxa. The holotype of the type species, *P. tayyo*, considered to be a mandibular tooth plate at the time of its description is identified as a palatine tooth plate. Mandibular tooth plates among the recently collected specimens are referred to this species and described. ❐ *Holocephali, Chimaeroidei, Chimaeridae, Callorhynchidae, Lower Cretaceous, Albian, Queensland, Great Artesian Basin, Toolebuc Formation, Allaru Formation, Edaphodon eyrensis, Ptyktoptychion wadeae sp. nov., Ptyktoptychion tayyo.*

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Fossilised remains of chimaeroids (Holocephali) are uncommon among the Lower Cretaceous fish faunas of Australia and only two occurrences of this age have been recorded in the past. Both described taxa are from sediments deposited during the Aptian and Albian marine transgressions within the Great Artesian Basin, a structure that exists over much of inland Queensland and parts of other Australian states.

The first taxon was based upon an isolated, weathered mandibular tooth plate from the Aptian Bulldog Shale at Lake Phibbs, South Australia and was described by Long (1985) as the chimaerid, *Edaphodon eyrensis*. The second was also based on an isolated occurrence that was considered to be a mandibular tooth plate. This was recovered from the Albian Toolebuc Formation from near Boulia, western Queensland. Lees (1986) described this taxon as the callorhynchid, *Ptyktoptychion tayyo*.

Additional material that became available to Lees after her published work in 1986 was prepared by her but remained undescribed in the Queensland Museum collections. These specimens also came from the Boulia area, from the Toolebuc Formation at Spring Creek on "Canary" Station. Chimaeroid specimens collected by Dr Mary Wade from the Toolebuc Formation at "Borce Park" Station, west of Richmond in central Queensland were found unprepared in her private collection after her recent death. These, together with a calcilutite concretion containing a chimaeroid palatine tooth plate from the Albian Allaru Formation at "Currane" Station, north of Dartmouth in central Queensland, were transferred and incorporated into the collections of the Queensland Museum. An isolated vomerine tooth plate from "Canary" Station was collected recently by Mr Tom Hurley and was generously made available to the author.

All of the previously undescribed specimens form the basis for the present study. The terminology applied to the tooth plates largely follows that outlined in Stahl (1999). Similarly, the classification adopted herein is that outlined in that review of work on the group. Didier (1995) notes that tooth plates represent one of the few holocephalan mineralised tissues and that most fossil representatives are known only from such elements. She states that potential problems exist with some tooth plate characters. A developmental continuity is apparent between the two types of hypermineralised tissue recognised, viz. rods and pads. It is suggested this may have systematic importance because factors such as the effect of wear on the surface pattern of such tissues is not able to be assessed. The present work continues to apply the traditional use of the nature of the surface distribution of hypermineralised tissue – tritors.

Preparation of the material has been by a combination of mechanical techniques and chemical treatment involving dilute acetic acid.

All specimens are lodged with the Queensland Museum, bearing QMF numbers.

ABBREVIATIONS. abs = aboral surface; ait = anterior inner tritor; aot = anterior outer tritor; lbm = labial margin; lgm = lingual margin; lht = laminated hypermineralised tissue; mt = median or middle tritor; os = oral surfaee; pit = posterior inner tritor; pot = posterior outer tritor; sm = symphyseal margin.

SYSTEMATIC PALAEONTOLOGY

Class CHONDRICHTHYES

Superorder HOLOCEPHALI

Order CHIMAERIFORMES

Suborder CHIMAEROIDEI Patterson, 1965

Family CALLORHYNCHIDAE Garman, 1901

Subfamily CALLINORHYNCHINAE Stahl, 1999

Genus **Ptyktoptychion** Lees, 1986

TYPE SPECIES. *Ptyktoptychion tayyo* Lees, 1986, from the Toolebuc Formation of Lower Cretaceous (Albian) age.

REVISED GENERIC DIAGNOSIS. Tooth plates large to very large, thickened and robust, with deseending lamina present, often prominent. Vomerine tooth plate with eupped oral surface and with sharp, dentate mesial and labial margins. Tritoral materiał over most of finely ridged anterior oral surface. Ridges low, numerous, subparallel, from deepest part of eupped surface to mesial and labial margins. Outermost ridge with tritoral material only along labial edge. Oral surfaces of both palatine and mandibular tooth plates deeply corrugated with ridges and grooves that subparallel the relatively deep symphyseal borders, except labiodistally in the palatine tooth plate which broadens the occlusal surface. Labial margin moderately to deeply indented, particularly in mandibular tooth plate. Tritors reduced, with middle tritor insignificant and with posterior inner tritor small to moderately large and vertical in palatine tooth plate and almost non-existent when present at all in the mandibular. Beak tritor with laminated tritoral tissue at base of labial surfaee mesially. Anterior inner tritor absent in mandibular tooth plate but present as vertical plate on outer side of innermost ridge in palatine tooth plate. Anterior outer tritor similarly developed but smaller and lower on middle ridge of palatine tooth plate and on the outer face of the middle ridge of the mandibular tooth plate. The posterior outer tritor reduced to series of knobs along labiodistal margin of palatine tooth plate and lining elongate trough and sides of groove inside labial margin. Aboral mandibular tooth plate surface gently convex but with broad, shallow groove parallel to and near labiodistal margin; palatine tooth plate with deep groove aborally, close to short, deep symphyseal surface. Labiodistal part of aboral surfaee angled orally from outer edge of this groove.

DISCUSSION

The presenee of large holocephalians in what has been considered by most workers to be sediments deposited under shallow-water marine conditions is somewhat perplexing. Stahl (1999) indicates that, with the exception of the possibly freshwater form, *Helodus simplex* Agassiz, holocephalians were and are marine animals that generally inhabit deep waters, although one taxon (*Hydrolagus* Gill) currently comes into shallower waters and *Callorhynchus* Lacépede itself breeds near shore. It is generally assumed that members of the group were slow swimming, bottom cruising and predominantly bottom feeding. Mesozoic species were often large and most exceeded a meter in length. From the size of the tooth plates in the species of *Ptyktoptychion* (and of *Edaphodon*) located in the Great Artesian Basin, size was certainly of this magnitude.

Food of members of the group is thought to have been mostly of bivalves and other molluscs, crustaceans and worms but larger forms could have included fish in their diets. Reduction in the surface expression of tritoral material, the form of the vomerine tooth plate and the dentate labial margins suggests that soft tissues were a major food preference. If present in sufficient numbers, large holocephalians could have been drawn to the abundant food sources present in the Cretaceous inland sea during the deposition of the Toolebuc Formation in Albian times. However, there is an abundance of detrital shell material in this Formation and little evidence of dominant, other bottom feeders that might have been associated with this aspect of the sediments. Physical reduction of hard, invertebrate skeletons undoubtedly occurred.

Recorded holocephalian tooth plates are robust and thus likely to have been readily fossilised. Their relative rarity suggests that numbers of individuals were most likely low. Absence to date of small individuals might also suggest that species recorded were not from populations breeding in the Basin but represented visitors from benthic

environments beyond the continent. However, all material recovered to date is from localities remote from the major oceanic link for the Basin, across the Euroka Shelf, immediately below what is now the Gulf of Carpentaria, a major journey for slow moving animals. It is considered most likely that the recorded taxa were indeed endemic and evolved especially to meet the conditions present in waters that were shallower than now suit most members of the group. Sharks and teleost predators of large size abounded in the Great Artesian Basin especially during the Albian, as did large to very large marine reptiles. These could have significantly culled numbers of smaller individuals of holocephalians if shallow-water breeding was occurring.

Ptyktoptychion tayyo Lees, 1986
(Figs 1–3)

Ptyktoptychion tayyo, Lees, 1986: 187.

MATERIAL EXAMINED. Holotype, QMF12987, nearly complete right palatine tooth plate, Toolebuc Formation of Lower Cretaceous (Albian) age from northeast paddock "Warra" Station, near Boulia, CWQ. QMF17853, partial left palatine tooth plate, Toolebuc Formation, Spring Creek, corner paddock, "Canary" Station, south-east of Boulia, CWQ; QMF17026, partial right mandibular tooth plate, Toolebuc Formation, corner paddock, Spring Creek, "Canary" Station, south-east of Boulia, CWQ: QMF17076, partial left mandibular tooth plate, Toolebuc Formation, corner paddock, Spring Creek, "Canary" Station, south-east of Boulia, CWQ.

AGE AND FORMATION. From the marine Toolebuc Formation of Lower Cretaceous (Albian) age.

REVISED DIAGNOSIS. Moderate sized. Length of palatine symphyseal margin in holotype is 53mm (but is 98mm in QMF17853), while width is 38mm, giving a minimal L: W ratio of 2.6. The length of the mandibular tooth plate is 110mm while the width is 35mm, yielding a L: W ratio of 3.1. Labial margins deeply dentate especially in mandibular tooth plate. Oral surface of palatine tooth plate with three ridges. Middle ridge about three-quarters as strongly developed as the innermost ridge. Grooves between all ridges deep. Four tritors present. Mandibular tooth plate with three tritors. Four ridges on oral surface at labial margin with inner three only progressively slightly weaker from innermost outwards and with three well defined grooves present.

DESCRIPTION. Known only from isolated palatine and mandibular plates.

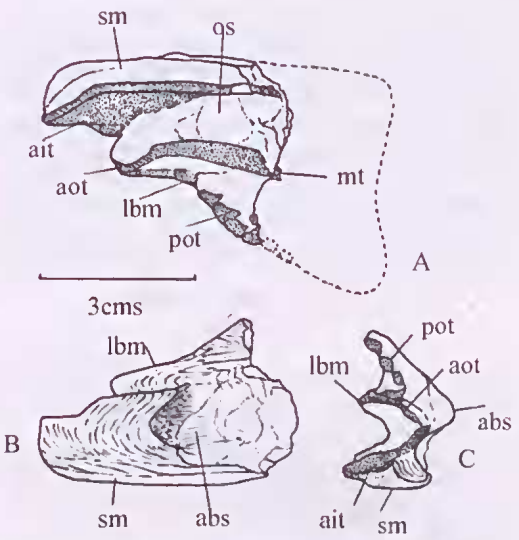

FIG. 1. *Ptyktoptychion tayyo* Lees, 1986, Holotype, QMF12987, partial right palatine tooth plate, see also Lees (1986) and Stahl (1999) for other illustrations; A, oral view (partially reconstructed); B, aboral view; C, mesial view; Scale = 3cms.

Holotype palatine tooth plate incomplete, lacking much of lingual and labiodistal margins but augmented by referred material. Tooth plate moderately robust, elongated triangular in shape. Length is ca. 98mm and width is ca.38mm (L: W ratio of 2.6). The symphyseal surface is short, deep, mesially triangular. Oral surface deeply corrugated with ridges and grooves. Innermost and middle ridges parallel symphyseal surface with middle ridge about three-quarters as high as the innermost ridge. Labial ridge low, set outwards at an angle of about 45° to the middle ridge. Mesially, end of inner ridge truncated and angled towards symphyseal surface. Labial surface of inner ridge with near vertical anterior inner tritor, extending sinuously along crest of ridge, sub-parallel to but not crossing deep groove curving down to indentation at labial margin. Anterior of crest angled sharply to labial margin. Labial surface of middle ridge with somewhat smaller, near vertical anterior outer tritor descending sharply anteriorly from crest to labial margin. Small knob of tritoral tissue present at margin on labial end of groove apparently associated with anterior outer tritor. Base of tritor curves into and sub-parallels deep groove between middle and labial ridges. At crest, tritor is turned outwards to broaden

surface, especially posteriorly. Posterior outer tritor present as series of three, low knobs along crest of low labial ridge, set outwards at an angle of ca. 45° to the labial face of the middle tritor. Labiodistal part of labial margin also angled orally at angle of ca. 45° to aboral base below inner ridge. Small posterior inner tritor present at crest of inner ridge. Aboral surface with deep, broad groove parallel to symphyseal margin, shallower mesially where roofed by strong

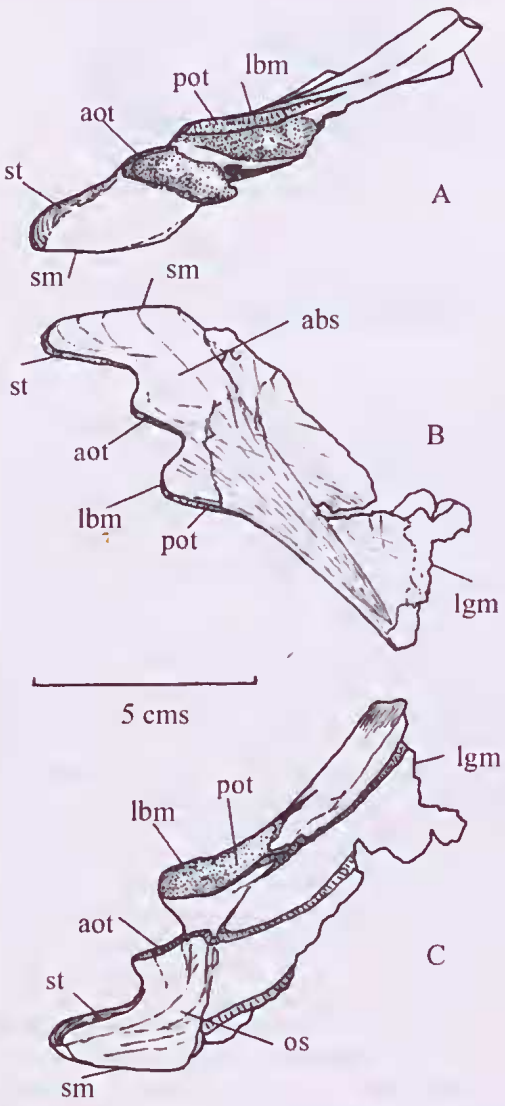

FIG. 2. *Ptyktoptychion tayyo* Lees, 1986, QMF17026, partial right mandibular tooth plate; A, labial view. B, aboral view; C, oral view; Scale = 5cms.

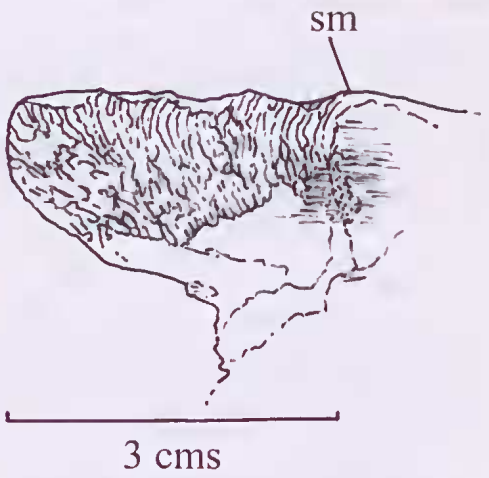

FIG. 3. *Ptyktoptychion tayyo* Lees, 1986, QMF17076, partial left mandibular tooth plate showing laminated tritoral tissue base exposed by weathering, oral view; Scale = 3cms.

descending lamina. Surface curves abruptly labially at angle of ca. 45° to base.

Mandibular tooth plate incompletely known. Tooth plate moderately robust, elongated and rhomboidal in shape. Length is 110mm and width is 35mm (L: W ratio of 3.1). Symphyseal surface is short, relatively deep, mesially triangular, bearing several longitudinal grooves parallel to aboral margin and slightly extended orally along oral margin. Oral surface deeply corrugated with ridges and grooves. Middle ridge apparently broadest and stoutest lingually, with mesial end dividing with inner part curving to above symphyseal margin contributing to crest of short, stout "beak". Outer and central parts form crests descending abruptly to dentate labial margin. These only slightly progressively lower than "beak". Outer ridge elongate but low and rounded, extending forwards along labiodistal part of labial margin to outermost dentate part. Major grooves along dentate part of labial margin deep, descending abruptly. Beak tritor present from mesial end, along dentate outer base of "beak" and across end of inner labial groove, composed of laminated hypermineralised tritoral tissue, grading internally into tritoral pad within "beak". Anterior inner, posterior inner and middle tritors absent. Anterior outer tritor near-vertical, forming outer face and crest of second dentate ridge. Posterior outer tritor elongate forming outer face and crest of third dentate ridge, lining shallow outer groove and forming part of

slightly raised labial margin. Descending lamina reasonably well-defined on aboral surface.

DISCUSSION

Lees (1986) concluded that, although the holotype of *Ptyktoptychion tayyo*, QMF12987, had a basically triangular outline typical of palatine tooth plates, its tritoral pattern indicated it represented a mandibular tooth plate. This situation was referred to in Stahl (1999) but was not remedied. It is clear that, with the larger samples now available, the specimen is a palatine tooth plate. The mandibular tooth plates described in the present study, although not found associated with palatine tooth plate remains of the same individual, are from specimens collected in similar sediments close to the type locality and have a close occlusal fit to the holotype corrugations, suggesting they are correctly referred to the same taxon.

A number of callorhynchids have palatine tooth plates that are subtriangular in outline and that have their posterior outer tritors subdivided into a number of "serial parts". None appears to have the deeply corrugated oral surface present in *P. tayyo*. The posterior inner and middle tritors in *P. tayyo* are generally less well-developed than in most of the other callorhynchids but are, regardless, present in the Queensland species as near-vertical walls of hypermineralised tritoral tissue in keeping with the anterior inner and outer tritors on the external faces of the ridges that descend to the labial margin. The dentate nature of the labial margin is also at variance with other recorded callorhynchine taxa. The genus *Ischyodus* Egerton has been recorded from Tertiary sediments in Australia (Stahl, 1999). If this palatine tooth plate occurrence represented *I. dolloi* Leriche as was suggested, some similarities exist with *P. tayyo*. The labial margin in the former is wavy, the shape is narrowly subtriangular and the posterior outer triton is represented by a series of small knobs. Mandibular tooth plates in *I. dolloi* have posterior and middle tritors that are much better developed, while the labial margin is less dentate. Both species have a laminated beak tritor. However, the deeply corrugated nature of the oral surface in *P. tayyo* is clearly distinctive. This feature alone serves to distinguish the Queensland species from the chimaerid, *Edaphodon eyrensis* Long, also from the Great Artesian Basin but from the slightly older Aptian sediments.

P. tayyo appears to have been the smallest of the known holocephalians living in the Lower Cretaceous inland sea of Australia. While its tooth plates were more graceful than those of the related species described herein, adult specimens may not have been greatly smaller in absolute size. Individuals probably exceeded a meter in length and were well equipped to cope with any of the small to medium sized, benthic organisms of the time and to have been capable of opportunistic feeding on midwater fishes and cephalopods.

Ptyktoptychion wadeae sp. nov.
(Figs 4–7)

MATERIAL EXAMINED. Holotype, QMF52601, almost complete right palatine plate lacking labiodistal and part of lingual margin and tip of beak, Toolebuc Formation of Lower Cretaceous (late Albian) age, from "Boree Park" Station, west of Richmond, NCQ. QMF52605, almost complete right vomerine tooth plate, "Canary" Station, south-east of Boulia, CWQ. QMF52603, almost complete right mandibular tooth plate, "Borec Park" Station, west of Richmond, NCQ. QMF52602, partial left mandibular tooth plate, "Boree Park" Station, west of Richmond, NCQ. QMF52604, partial left palatine tooth plate, Allaru Formation of Lower Cretaceous (late Albian) age, from "Currane" Station, north of Dartmouth, CWQ.

AGE AND FORMATION. From the marine Toolebuc and Allaru Formations of Lower Cretaceous (late Albian) age.

ETYMOLOGY. For the late Dr Mary Wade.

DIAGNOSIS. Tooth plates very large, very robust. Length of symphyseal margin in the holotype palatine plate is 101mm, while width of the oral surface across the back of the posterior outer tritor is 48mm, a L: W ratio of 2.1. (total length was presumably greater). The referred vomerine tooth plate has a symphyseal margin length of 74mm, while the width is 29mm. The mandibular tooth plate is 146mm long (ca. 156mm with the broken beak tritor restored) and 59mm wide at

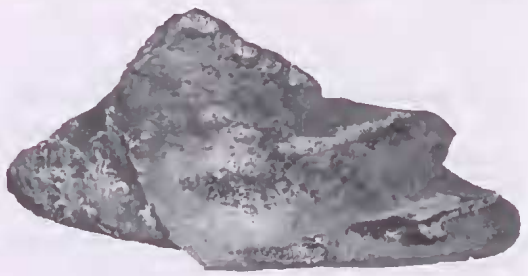

FIG. 4. *Ptyktoptychion wadeae* sp. nov., Holotype, QMF52601, partial right palatine tooth plate; Oral view; Scale = 5cms.

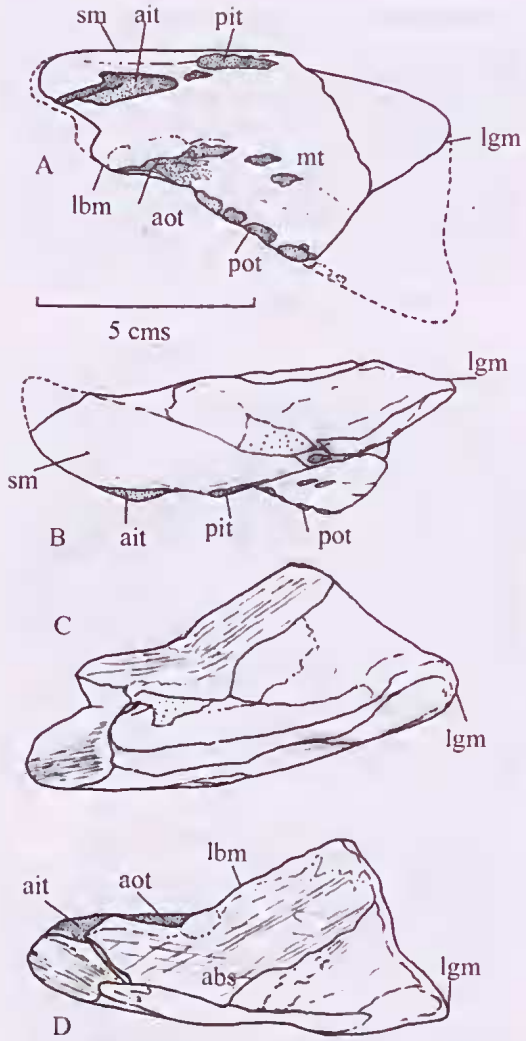

FIG. 5. *Ptyktoptychion wadeae* sp. nov., Holotype, QMF52601, partial right palatine tooth plate; A, oral view (partially reconstructed); B, symphyseal view; C, aboral view; D, labial view (oblique); Scale = 5cms. .

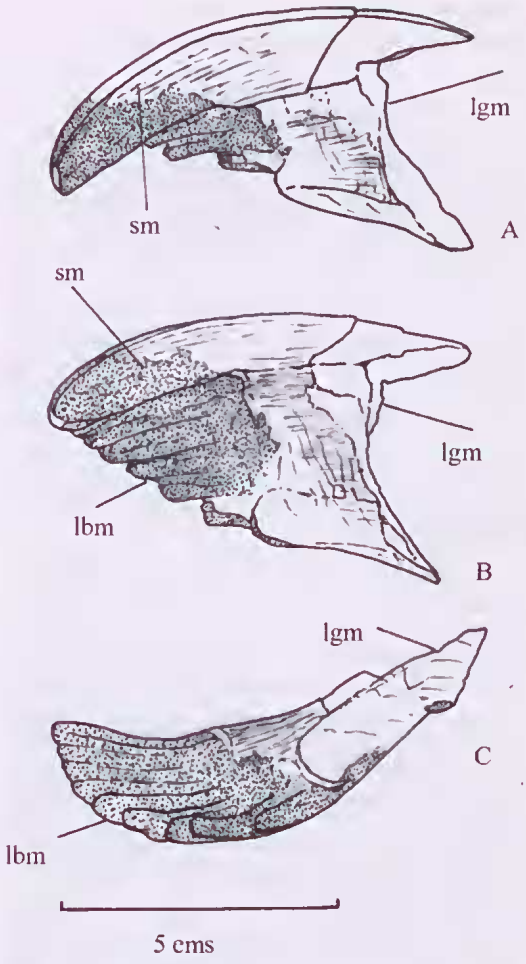

FIG. 6. *Ptyktoptychion wadeae* sp. nov., QMF52605, right vomerine tooth plate; A, symphyseal view; B, oral view; C, labial view; Scale = 5cms.

the back of the posterior outer tritor- a L: W ratio of 2.7. Labial margins dentate, especially in the mandibular tooth plate. Oral surface in palatine tooth plate corrugated, with three ridges diminishing significantly in strength from that parallel to the symphyseal margin to that along the labiodistal margin. Middle ridge less than half as well developed as the innermost ridge. Grooves between ridges broad, shallow. Five tritors present. Vomerine tooth plate relatively large, with oral surface deeply cupped, finely corrugated by nine ridges, across anterior tritor labially from mesial beak. Labial margin anteriorly finely dentate with sharpened cutting margin.

Mandibular tooth plate with five tritors. Oral surface corrugated with five ridges at or above labial margin. Lingually, oral surface ridges reduced to three, with middle ridge highest and strongest, radiating labiomesially into three. Labial margin moderately dentate, with three broad, low grooves separating ridges at margin. A descending lamina present on all tooth plates.

DESCRIPTION. Holotype palatine tooth plate incomplete but very large, robust, lacking tip of mesial margin and rear of tooth plate including labiodistal margin. Labial margin indented

anteriorly. Oral surface corrugated with three ridges decreasing in strength from that below the symphyseal margin outwards. The middle ridge is less than one-half as high as that below the symphyseal margin. The outer ridge is even less well developed than the middle ridge but is as high as the innermost ridge because of marked downwards flexure of the labial part of the tooth plate. Twisting of the tooth plate is accentuated by upwards and medial flexure of the back part of the inner ridge behind the symphysis. Both the posterior of the middle ridge and the labial ridge are angled outwards at about 30° to the front of the middle ridge. The grooves between the ridges are broad and shallow. Five tritors are present. Anterior inner tritor largest on outer, near vertical side of inner ridge. Anterior outer tritor smaller, present on outer, near vertical surface of middle ridge. Posterior outer tritor low, produced into three knobs along strongly inclined labiodistal margin and also set at an angle of ca. 45° to the anterior outer tritor. Posterior inner tritor very small with even smaller knob of subdivision anteriorly. Anterior outer tritor moderately well developed on outer, near vertical surface of middle ridge, extending back from labial margin. Posterior outer tritor present as series of five small knobs of tritoral material along crest of outer ridge (six in QMF52605). Middle tritor very small, present as series of two knobs of tritoral tissue subparallel to posterior outer tritor (four in QMF52605). Aboral surface bearing a deep, broad, longitudinal groove outside symphysis, probably capped anteriorly. Descending lamina prominent.

Vomerine tooth plate relatively large, with oral surface shaped like a cupped hand. Symphyseal margin crescent-shaped in symphyseal view, deep towards middle of tooth plate. Mesial and labial margins relatively sharp, dentate. Tritoral material present over most of front of oral surface as subparallel, low ridges running from deepest part of cupped surface and slightly behind this to mesial and labial margins. Hypermineralised tritoral tissue present as laminated overlapping plates, especially along oral surfaces of ridges within cupped surface, together with a mixture of minute, bead-like surface dots and tritoral pads. Beak slightly hooked. Ridges shorten and broaden towards outer part of labial margin, while outermost ridge with tritoral material only at labial edge, continuing along deep edge of margin. Aboral surface strongly convex longitudinally and transversely with descending lamina present but weak. Lingual margin open.

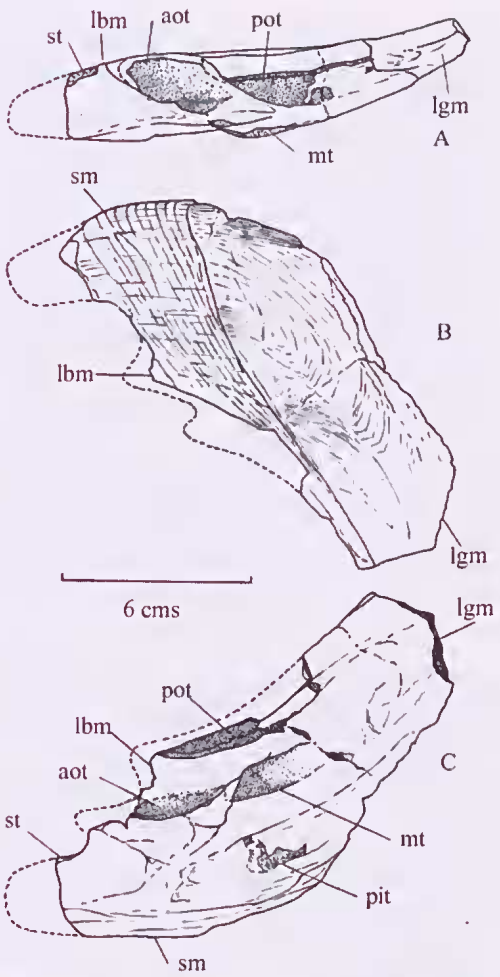

FIG. 7. *Ptyktoptychion wadeae* sp. nov., QMF52603, partial right mandibular tooth plate, all partially reconstructed; Scale = 6cms; A, labial view; B, aboral view; C, oral view.

Mandibular tooth plate large, robust, with sublunate oral surface and dentate oral margin. Aboral surface gently convex longitudinally and more strongly so transversely, sometimes with very shallow, broad, longitudinal depression towards outer oral margin. Symphyseal margin deep, with irregular, longitudinal ridges and grooves, gently convex aborally and narrowing posteriorly. Symphyseal margin extends anteriorly along short, robust, symphyseal beak, subtriangular in section. Oral surface with very strong, broad, longitudinal ridge on mid-posterior moiety, dividing into three angular ridges anteriorly, one to back of symphyseal beak, and the others to delimit the angled edges of broad grooves that descend to the oral margin.

A broad, shallow groove runs longitudinally between the middle ridge and the upper rim of the symphyseal margin. A low rounded ridge at posterior of oral margin subparallel to symphyseal margin and is separated from middle ridge by narrow groove that broadens anteriorly. Up to five tritors present. Symphyseal tritor moderately large, developed towards base of beak along oral margin, with edges mostly of parallel, overlapping and inclined, semi-circular lamelli, grading inwards into pads. Posterior inner tritor usually not developed, middle tritor small and strap-like, anterior outer tritor restricted to inner wall of middle groove, while more extensive posterior outer tritor lines sides and base of oral end of outer groove, including forming much of posterior rim of oral margin. Aboral surface generally marked by very minor, longitudinal ridges, intersecting with one or two angled sets of slightly stronger, transverse ridges. Descending lamina moderately prominent.

DISCUSSION

It is possible that QMF52601, the holotype palatine tooth plate of *P. wadeae* sp. nov. and the referred mandibular tooth plates (QMF52603 and QMF52602) were all derived from the one individual. Unfortunately, full details of the collection of the material were not included with the specimens located in the effects of Dr. Wade following her death. For this reason, only the palatine tooth plate has been designated as the holotype to facilitate separation of *P. wadeae* from *P. tayyo* Lees. The vomerine tooth plate could have been associated with the latter taxon, coming as it did from a locality close to the type locality for that species. However, it is clearly more robust than would have been expected for *P. tayyo* and thus appears to be more reasonably referrable to *P. wadeae*.

The occurrence of *P. wadeae* in a calcilutite nodule from the Allaru Formation at "Currane" Station, north of Dartmouth, is of interest. The locality has produced a broad faunal assemblage of marine invertebrates that can only be interpreted as being of near-shore, shallow-water origin. Among these is a broad crustacean fauna reported upon by Woods (1953). Such animals would have provided an ideal food source for *P. wadeae* and their remains support the conclusion that the holocephalans of the Great Artesian Basin were unlike the bulk of their living relatives in frequenting shallow and even near littoral marine habitats.

ACKNOWLEDGEMENTS

Dr Alex Cook of the Queensland Museum is thanked for referring the material located in the effects of the late Dr Mary Wade to the author and for the transfer of the vomerine tooth plate from "Canary" Station. Mr Tom Hurley is especially thanked for his generosity in donating that specimen to the Queensland Museum. Thanks are also extended to Dr Susan Turner who made literature available and who discussed the taxonomic issues involved.

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